Dichroic/TN

YTH TRANSLATION
JP (A) 54-43048

Applied: September 12, 1977
Application No.: 52-108767
Laid-open: April 5, 1979

Title: A color liquid crystal display device

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1. Title of Invention

A color liquid crystal display device

2. Region of Patent Requested

Claim 1

A color liquid crystal display device which characteristically possesses a dichromatic pigment and nematic liquid crystal or a liquid crystal comprising a dichromatic nematic liquid, being sealed in between two sheets of the substrates which have transparent electrodes and are aligned to form a twisted liquid crystal layer, along with a reflective sheet, wherein the said transparent electrodes are formed on at least one of the transparent substrates in a comb-tooth like shape and the information is displayed by the changes in the molecular alignment through the electric field applied between the said comb-tooth like transparent electrodes.

Claim 2

The color liquid crystal display device described in Claim 1 wherein the twisted liquid crystal layer characteristically comprises a dichromatic pigment and an n-type nematic liquid crystal or an n-type dichromatic nematic liquid crystal.

Claim 3

A color liquid crystal display device which characteristically possesses a dichromatic pigment and nematic liquid crystal or a liquid crystal comprising a dichromatic nematic liquid, being sealed in between two sheets of the substrates which have transparent electrodes and are aligned to form a twisted liquid crystal layer, along with a reflective sheet, wherein the said transparent electrodes are formed on at least one of the transparent substrates in a comb-tooth like shape, a polarizer is located between the said substrate and the reflective sheet, and the information is displayed by the changes in the molecular alignment through the electric field applied between the said comb-tooth like transparent electrodes.

Claim 4

The color liquid crystal display device described in Claim 3 wherein the twisted liquid crystal layer characteristically comprises a

dichromatic pigment and an n-type nematic liquid crystal or an n-type dichromatic nematic liquid crystal.

3. Detailed Explanation of Invention

The present invention relates to a color liquid crystal display device which applies the electro-optical effect of the liquid crystal in order to achieve a monochromatic color display.

For the device which holds a liquid crystal between two sheets of the substrates, changes the molecular alignment by applying the electric field to the liquid crystal, and displays the information by altering the optical properties, two sheets of a top and a bottom transparent electrodes have been required, as shown in Figure 1. Figure 1 shows a top substrate 1, a transparent electrode 2, a liquid crystal layer 3, and a bottom substrate 4. Since two sheets of the transparent electrodes are necessary, they must be formed on both the top and bottom substrates. In addition, the process is required to precisely match the locations of the facing top and bottom transparent electrodes. Further when the cell is connected with the external circuit, the electrical connection was not easy and the reliability of the connection was low due to the formation of electrodes on each of the both substrates. These problems can be solved if the liquid crystal may be driven by the electrodes formed on one of the two substrates. The known method to drive the liquid crystal by the electrodes formed on one substrate is to utilize the comb-tooth like electrodes which are fine parallel electrodes facing to each other on the same surface plane, as shown in Figure 2. Figure 2 (b) is a cross-sectional diagram, indicating the transparent electrodes 5 and the substrate 6. An example of employing the comb-tooth like electrodes to the LCD device is the LCD device which seals in the nematic liquid crystal having a homogeneous alignment or a twisted structure between the glass sheet without transparent electrodes and the glass sheet having the comb-tooth like transparent electrode. The operation principle of this liquid crystal cell is as follows: a voltage is applied between the comb-tooth like transparent electrodes facing to each other, an electric field is formed between the comb-tooth like transparent electrodes facing to each other, and the optical properties are altered by the rotation of the liquid crystal molecules. In the said literature, the display of the information is possibly demonstrated through the changes in the optical transmittance by combining with polarizers. However, the display method employing the liquid crystal cell of this constitution can present only the black-and-white display, not a color display. Currently, coloring of the liquid crystal display is in a strong demand, however, the said liquid crystal cell can not respond to such a demand. Coloring of a LCD device having the comb-tooth like transparent electrode necessitates the evaluation of electro-optical effects for the utilized liquid crystal.

A known color display method with a liquid crystal is the guest-host effect method wherein an electric field is applied to the nematic liquid crystal having a trace amount of a dichromatic pigment and the information is displayed by altering the light absorption by the

pigment. The combination of the comb-tooth like electrodes with the guest-host effect may possibly lead to the color display. In the conventional guest-host effect method, the electric field was applied to the liquid crystal by the method shown in Figure 3. Figure 3 indicates a liquid crystal molecule having a positive dielectric anisotropy 9, a dichromatic pigment 10, a lead wire 11, and a power supply for the liquid crystal driving 12. The dichromatic pigment absorbs light which is polarized parallel to its molecular long axis. Therefore, the section which has no applied electric field in Figure 3 is colored by the absorption of light by pigment. The light polarized perpendicular to the molecular long axis of the dichromatic pigment is not absorbed by the pigment, therefore, the section with the applied electric field in Figure 3 presents the color fading due to no color absorption. As a display, it is desirable to display by a color than by a color fading, however, no adequate methods have been known. As described above, the conventional guest-host method disadvantageously displayed the display sections by the color fading conditions.

The present invention improves the LCD method which drives the liquid crystal by the transparent electrodes formed on one substrate in order to make the display in color, and offers the LCD device which improves the guest-host effect and presents the display sections in color.

The present invention is characterized by that a dichromatic pigment and nematic liquid crystal or a dichromatic nematic liquid crystal, which form a twisted liquid crystal layer, are held between two sheets of substrates, at least one of which have the comb-tooth like transparent electrodes, along with polarizers.

In the following section, the principle and the example are interpreted by referencing figures. Figures 4 (a) and 4 (b) indicate one example of the present invention and are the cross-sectional diagrams at the perpendicular direction from the length direction of the comb-tooth like transparent electrodes. Figures 4 (a) and (b) indicate the top substrate 1, the bottom substrate 4, the comb-tooth like transparent electrodes 5, the liquid crystal molecule 9, the dichromatic pigment molecule 10, a polarizer 13, and a reflective sheet 14. The polarization direction of the polarizer is parallel to the paper plane. The substrate surface is treated for alignment so that the p-type liquid crystal molecules and the dichromatic pigment molecules align parallel to the paper plane at the top substrate surface and perpendicularly to the paper plane at the bottom substrate surface while aligning their molecular long axis parallel to the substrate surface. Large arrows 41 and 42 within the figure indicate the direction of light advancement. In the figures, circles 16 to 39 present the polarized light at these locations and arrows within these circles indicate the light polarization direction. The side way arrows mean that the light is polarized parallel to the paper plane, while the up-and-down arrows indicate that the light is polarized perpendicular to the paper plane. Figure 4 (a) is the case when no voltage is applied to the liquid crystal. The direction shown by 17 corresponds to the polarized light at the wavelength of the pigment absorption. Among the polarized light of the incident light having a wavelength of

the pigment absorption, that which matches with the molecular long axis direction of the dichromatic pigment molecule is absorbed by the pigment molecule while passing through the liquid crystal layer. Therefore after passing through the liquid crystal layer, only the polarized light parallel to the paper plane remains, as shown by the arrow in the circle 17. On the other hand, any polarized light of the light outside of the pigment absorption wavelength may not be absorbed by the pigment. As a result, it is polarized to all the directions even after passing through the liquid crystal layer. The polarization direction of the polarizer 13 is parallel to the paper plane, therefore, it allows the passing of the light at the pigment absorption wavelength, which was polarized to the paper plane direction. Further it also passes the light parallel to the paper plane among the light beams at the wavelengths outside of the pigment absorption wavelength, which are polarized to all the directions. The light which passed the polarizer is now polarized parallel to the paper plane at any wavelength, as shown in the arrow within the circle 18. The light is reflected by the reflective sheet 14 without changing the polarization direction, and passes through the polarizer again, while maintaining the polarization direction parallel to the paper plane as shown by the circle 20. The polarized light parallel to the paper plane passes through the liquid crystal layer while being perpendicular to the long axis direction of the pigment molecule. Therefore, it advances within the liquid crystal layer without being absorbed by the pigment molecule and goes back to the air after passing the top substrate. When the electric field is zero, the light absorption effect by the pigment is small as described above, therefore, the liquid crystal cell does not show a strong coloring.

Figure 4 (b) presents the case when the voltage is applied between the comb-tooth like transparent electrodes. The dotted lines 15 are the lines of electric force. Figure 2 (a) presents the method to apply the voltage between the comb-tooth like transparent electrodes. Figure 2 (a) indicates a lead wire 7 and the driving power supply 8. The existence of the voltage difference between the facing comb-tooth like electrodes generates the lines of electric force indicated by the dotted lines 15 in Figure 4 (b). Since the employed liquid crystal is a nematic liquid crystal of which dielectric ratio is larger in the long axis direction than the short axis direction, the long axis of the liquid crystal molecules realigns parallel to the paper plane along the direction of the lines of electric force, as shown in Figure 4 (b). The dichromatic pigment molecules mixed into the liquid crystal follow the surrounding liquid crystal molecules and realign their long axis direction parallel to the paper plane, as shown in Figure 4 (b). This realignment is solely achieved by the rotation of the liquid crystal molecules within the plane parallel to the substrate, therefore, the response time towards the electric field is short. Optical properties of the sections without electrodes are the same as the case shown in Figure 4 (a). Large arrows in Figure 4 (b) present the light advancement direction which passes through the section with the comb-tooth like electrodes. Arrows within the circles 22 through 27 indicate the light polarization direction for the light that passes through the section with the comb-tooth like electrodes. The circle 22 indicates that the incident light is polarized to all the directions.

Among the incident light having a wavelength of the pigment absorption, the polarized light component parallel to the paper plane matches its polarization direction with the molecular long axis direction of the dichromatic pigment molecule, thus being absorbed by the pigment. Therefore after passing through the liquid crystal layer, only the polarized light perpendicular to the paper plane remains among the light at the absorption wavelength of the pigment, as shown by the arrow in the circle 23. This polarization direction is perpendicular to the polarization direction of the polarizer which is parallel to the paper plane. Therefore, the light at the absorption wavelength of the pigment does not reach to the reflective sheet. Then the light at the absorption wavelength of the pigment is missing within the light that goes back from the liquid crystal cell, leading to a strong coloring at the section of the comb-tooth like transparent electrodes. In other words, application of the voltage between the comb-tooth like transparent electrodes can strongly color the liquid crystal cell.

Figures 5 (a) and (b) indicate another example of the present invention by utilizing an n-type nematic liquid crystal, and they are the cross-sectional diagrams at the perpendicular direction from the length direction of the comb-tooth like transparent electrodes. The polarizing direction of the polarizer is parallel to the paper plane.

By applying the alignment treatment to the substrate surface, the n-type liquid crystal molecules and the dichromatic pigment are aligned perpendicular to the paper plane at the top substrate surface and parallel to the paper plane at the bottom substrate surface while aligning their molecular long axis parallel to the substrate surface. Figure 5 (a) is the case of no applied electric field. The light at the wavelength of the pigment absorption which has passed through the liquid crystal layer once is absorbed by the pigment by the same mechanism presented in Figure 4, and possesses only the light polarized to the perpendicular direction of the paper plane, as shown in 29. Then this light passes through the polarizer of which polarizing direction is perpendicular to the paper plane, and passes through the polarizer again after being reflected by a reflective sheet. The light is polarized perpendicular to the long axis direction of the pigment molecule, therefore, it advances within the liquid crystal layer without being absorbed by the pigment molecule and goes back to the air after passing the top substrate. When the electric field is zero, the light absorption effect by the pigment is small as described above, therefore, the liquid crystal cell does not show a strong coloring. Figure 5 (b) presents the case when the voltage is applied between the comb-tooth like transparent electrodes. The n-type liquid crystal, of which dielectric ratio is larger in the perpendicular direction to the long axis direction than the long axis direction, rotates within the plane parallel to the substrate and realigns the long axis of the liquid crystal molecules perpendicular to the paper plane, as shown in Figure 5 (b). The dichromatic pigment molecules follow the surrounding liquid crystal molecules and realign their long axis direction perpendicular to the paper plane. Arrows within the circles 34 through 39 indicate the light polarization direction for the light that passes through the section with the comb-tooth like electrodes. The circle 35 indicates that the light at the absorption wavelength of the pigment is

polarized in parallel to the paper plane. This polarization direction is perpendicular to the polarization direction of the polarizer. Therefore, the light at the absorption wavelength of the pigment does not reach to the reflective sheet. Then the light at the absorption wavelength of the pigment is missing within the light going back from the liquid crystal cell, leading to a strong coloring at the section of the comb-tooth like transparent electrodes.

The present invention simplifies the structure of the liquid crystal cell, by combining the comb-tooth like transparent electrodes and the guest-host effect, and allows to form the transparent electrodes only on one substrate. Therefore, the raw material cost of the liquid crystal cell is reduced, and the assembly process of the liquid crystal cell becomes easy by eliminating the necessity for the positioning of the facing electrodes on the top and bottom substrates. In addition, a lead wire can be introduced from one substrate, which makes it easy to connect the liquid crystal cell with the external circuit and increases the connection reliability. Further the display sections can be presented in color and, as a result, the high quality display device easy for human eyes became possible. Further, the application of the electric field realigns the liquid crystal molecules by their rotation within the same plane, which greatly improves the response time.

4. Simple Explanation of Figures

Figures 1 , 2 and 3 present the conventional liquid crystal cell. Figure 1 is a cross-sectional diagram, Figure 2 (a) is a front view of the comb-tooth like transparent electrodes, Figure 2 (b) is a cross-sectional diagram of Figure 2 (a) from the perpendicular direction, and Figure 3 interprets the guest-host effect method. Figures 4 and 5 present the examples of the LCD device of the present invention. Figure 4 (a) presents the condition when no voltage is applied to the p-type liquid crystal, and Figure 4 (b) is the case when a voltage is applied to the comb-tooth like electrodes. Figure 5 (a) presents the condition when no voltage is applied to the n-type liquid crystal, and Figure 5 (b) is the case when a voltage is applied to the comb-tooth like electrodes.

5 - comb-tooth like transparent electrodes
9 - nematic liquid crystal molecule
10 - dichromatic pigment molecule
13 - polarizers
16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39 -light polarization vectors

Figure 1

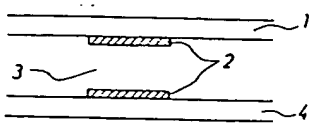


Figure 2

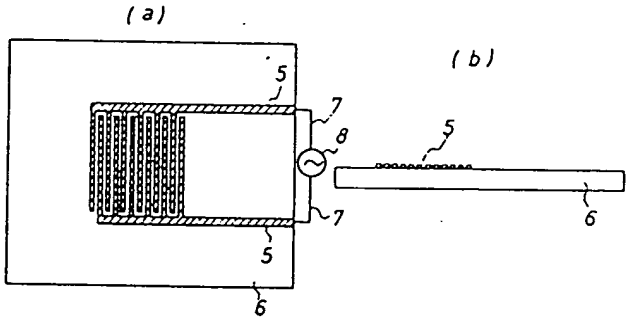


Figure 3

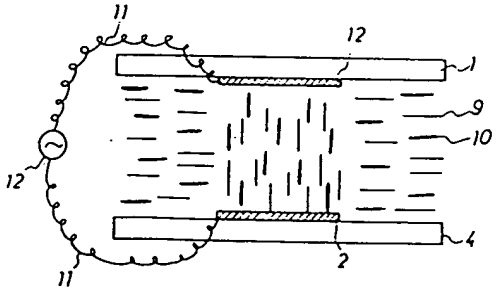


Figure 4

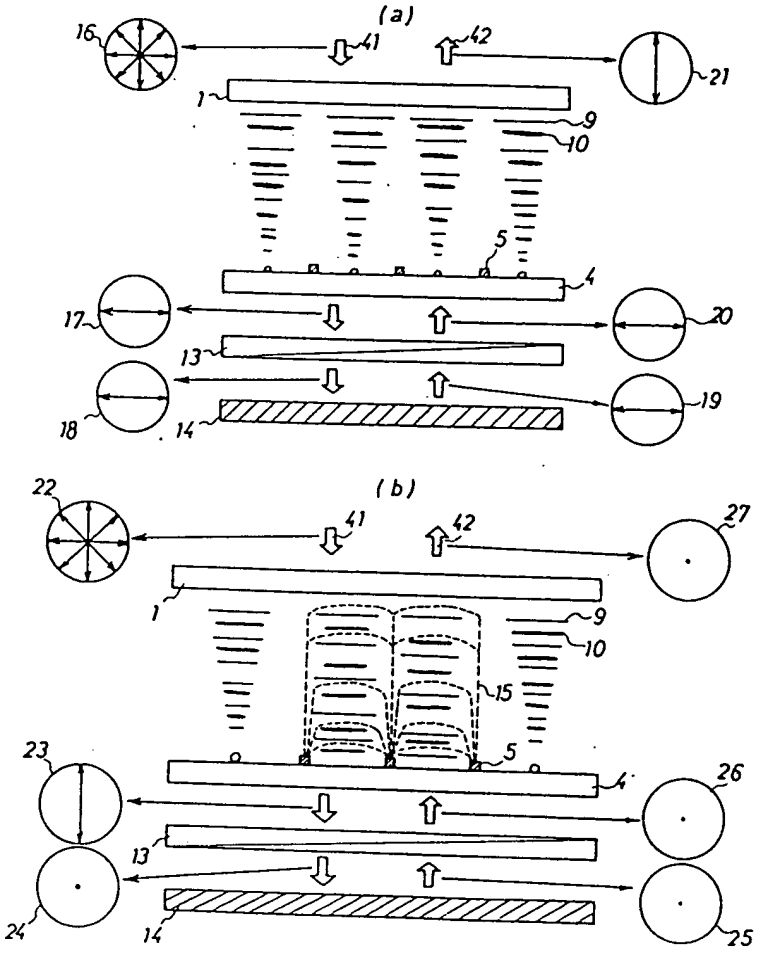
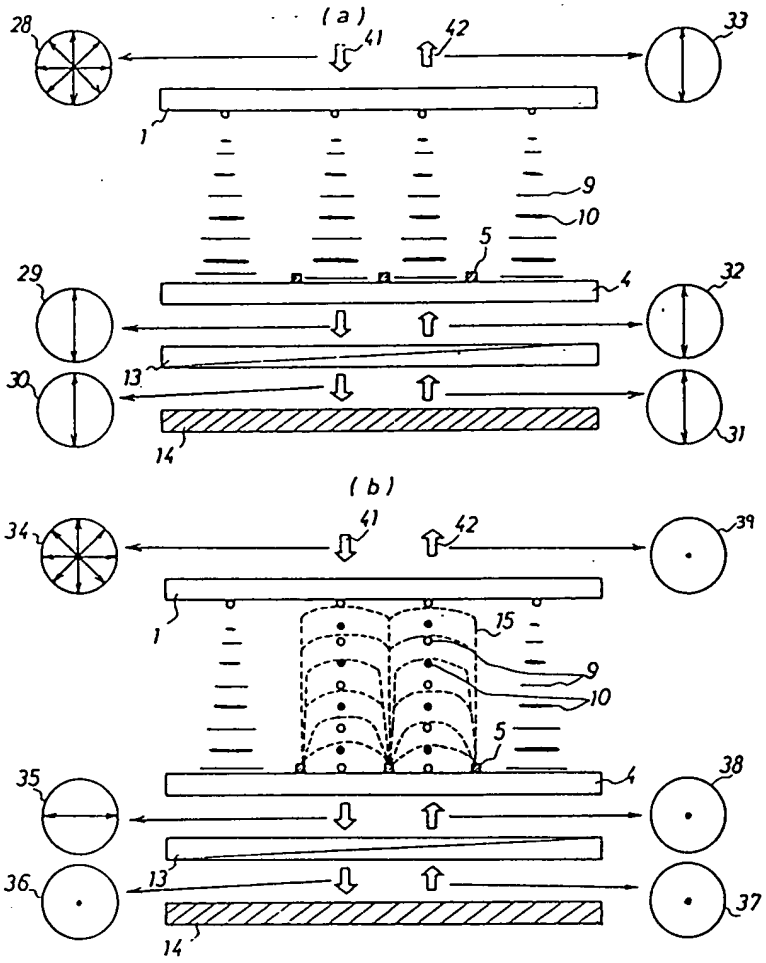


Figure 5


(a)
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SS 1 RESULT (1)

-1- (JAPIO)

ACCESSION NUMBER	79-Ø43Ø48
TITLE	LIQUID CRYSTAL COLOR DISPLAY DEVICE
PATENT APPLICANT	(2ØØØ196) CITIZEN WATCH CO LTD
INVENTORS	MASUBUCHI, SADAO
PATENT NUMBER	79.Ø4.Ø5 J54Ø43Ø48, JP 54-43Ø48
APPLICATION DETAILS	77.Ø9.12 77JP-1Ø8767, 52-1Ø8767
SOURCE	79.Ø5.31 SECT. E, SECTION NO. 114; VOL. 3, NO. 64, PG. 148.
INT'L PATENT CLASS	GØ2F-ØØ1/13; GØ9F-ØØ9/ØØ
JAPANESE PATENT CLASS	1Ø4GØ; 1ØIE9; 1ØIE5
JAPIO CLASS	29.2 (PRECISION INSTRUMENTS--Optical Equipment); 29.3 (PRECISION INSTRUMENTS--Horologe); 29.4 (PRECISION ENTS--Business Machines); 44.9RU (COMMUNICATION--Other)
FIXED KEYWORD CLASS	RØ11 (LIQUID CRYSTALS); R1Ø9 (INSTRUMENTATION--Digital Clocks & Watches); R11Ø (INSTRUMENTATION--Digital Display Instrumentation)
ABSTRACT	PURPOSE: To improve guest-host effect and let color displaying using colored portions be performed by sealing (n) type nematic liquid crystal in twisted type together with dichromatic dyes in the cell formed by a polarizing plate, two sheets of substrates at least one of which is provided with transparent comb-tooth type electrodes, etc. thereby forming the display device.

SS 2?

(19)日本国特許庁(JP)　(11)特許出願公開

(12)公開特許公報(A)　昭54—43048

(51)Int. Cl.²	識別記号	(52)日本分類	庁内整理番号	(43)公開 昭和54年(1979)4月5日
G 02 F 1/13		104 G 0	7348—2H	
G 09 F 9/00		101 E 9	7013—5C	発明の数 2
		101 E 5		審査請求 未請求

(全 5 頁)

(54)液晶色表示装置

(21)特　願　昭52—108767
(22)出　願　昭52(1977)9月12日
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明　細　書

1. 発明の名称

液晶色表示装置

2. 特許請求の範囲

(1) 透明電極を付設し配向処理を施した対向する2枚の基板間に2色性色素とネマチック液晶又は2色性ネマチック液から成る液晶をねじれ液晶層に形成して封入し且つ反射板を配設し、前記透明電極を少なくとも1枚の基板上にくし歯状に形成すると共に前記くし歯状透明電極間に電界を印加し、分子配列を変化して情報を表示することを特徴とする液晶色表示装置。

(2) 特許請求の範囲第1項記載の液晶のねじれ液晶層は2色性色素とp型ネマチック液晶またはp型2色性ネマチック液晶から成ることを特徴とする液晶の色表示装置。

(3) 透明電極を付設し、配向処理を施した対向する2枚の基板間に2色性色素とネマチック液晶又は2色性ネマチック液晶から成る液晶をねじれ液晶層に形成して封入し、且つ反射板を配設し、前記透明電極を少なくとも1枚の基板上にくし歯状に形成すると共に前記反射板と基板との間に絶縁板を配設し、前記くし歯状透明電極間に電界を印加し、分子配列を変化して情報を表示することを特徴とする液晶色表示装置。

(4) 特許請求の範囲第3項記載の液晶のねじれ液晶層は2色性色素とp型ネマチック液晶又はp型2色性ネマチック液晶から成ることを特徴とする液晶色表示装置。

3. 発明の詳細な説明

本発明は液晶の電気光学的効果を応用した、単色で文字表示を行なう液晶色表示装置に関する。

液晶を2枚の基板間に封入して液晶に電界を加えてその分子配列を変化させ、光学的性質を変化させて情報を表示する装置においては、第1図に示すように上下2枚の透明電極が必要であつた。第1図で1は上基板、2は透明電極、3は液晶層、4は下基板である。2枚の透明電極が必要であるために、上下2枚の基板に透明電極を形成する必

要があり、2枚上下の対向する透明電極の位置を正確に合わせる工程が必要であつた。さらにセルと外部回路を接続する場合に、2枚の基板のそれぞれに電極が形成されているので、電気的接続が容易でなく、接続の信頼性が低かつた。これらの問題点は2枚の基板の1枚に設けられた電極で液晶を駆動できれば解決できる。1枚の基板上に形成された透明電極で液晶を駆動する方法としては第2図に示すような細い平行電極を同一平面上で対向させたくし歯状電極が知られている。第2図(b)は断面図で、5が透明電極、6が基板である。くし歯状透明電極を液晶表示装置に用いた例として、透明電極なしのガラス板とくし歯状透明電極の形成されたガラス板の間に平行配向やねじれ構造を有するネマチック液晶を封入した液晶表示装置が知られている。この液晶セルの動作原理は、くし歯状の対向する透明電極間に電圧を印加して対向するくし歯状透明電極間に電界を作り、液晶分子を回転して光学的性質を変化させるものである。前記論文では、偏光板と組み合わせて光の透過率を変化させて情報を表示することが可能であることを示している。しかし、この構成の液晶セルを用いた表示方式では、白黒表示のみが可能であつて、カラー表示は不可能である。今日では、液晶表示のカラー化が強く要求されているが、前記の液晶セルではこの要求に答えることができない。くし歯状透明電極を有する液晶表示装置のカラー化を行なうためには、用いる液晶の電気光学効果を検討する必要がある。

液晶によるカラー表示方式として、2色性の色素を重量混合したネマチック液晶に電場を印加して色素による光の吸収度を変化させて情報の表示を行なうゲストホスト効果方式が知られている。くし歯状電極とゲストホスト効果を組み合わせることによりカラー表示が可能になると考えられる。従来ゲストホスト効果方式では、第3図に示すような方法で液晶に電場を印加していた。第3図で9は正の誘電異方性を有する液晶分子、10は2色性の色素、11はリード線、12は液晶駆動用電源である。2色性の色素はその分子長軸に平行に偏光している光を吸収するので、第3図の電場の印加されていない部分は色素の吸収波長の光が吸収されて着色する。2色性の色素の分子長軸に垂直方向に偏光している光は色素で吸収されないので、第3図で電場が印加されている部分は色の吸収がないので色抜けする。表示としては、色抜けとして表示するよりも着色状態で表示することが望ましいが、良好な方法が知られていなかつた。このように従来のゲストホスト効果方式では表示部分が色抜けの状態として表示される欠点があつた。

本発明は液晶の駆動を1枚の基板上に形成された透明電極で行なう液晶表示方式を改善し、表示をカラー化するとともにゲストホスト効果を改善し、着色部分を用いて表示を行なう液晶色表示装置を提供する。

本発明では偏光板を用いて2枚の基板の少なくとも一方にくし歯状透明電極を形成した基板間に2色性色素とネマチック液晶または2色性ネマチック液晶をねじれ液晶層を形成するよう封入することを特徴としている。

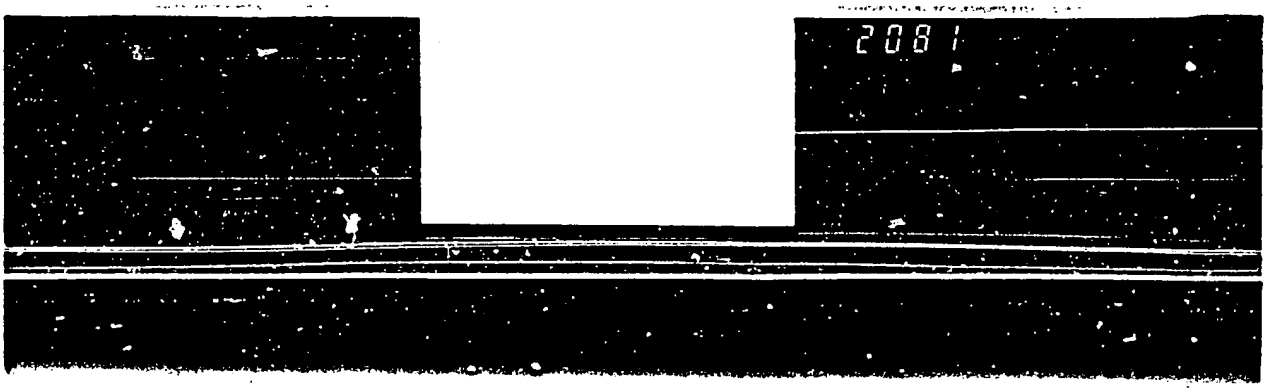
次に図面により原理および実施例を説明する。第4図(a)、(b)は本発明の一実施例を示す図である。くし歯状透明電極の長手方向に直角方向の断面図である。第4図(a)、(b)で1は上基板、4は下基板、5はくし歯状透明電極、9は液晶分子、10は2色性色素分子、13は偏光板、14は反射板である。偏光板は板面に平行方向に偏光方向を有している。基板面に配向処理を施し、P型の液晶分子および2色性色素分子はそれらの分子長軸が基板面に平行で、上基板面上では紙面に平行に、下基板面上では紙面に垂直に配列させる。図中の大きい矢印41、42は光の進行方向を表わしている。16～39は光がその位置における偏光を示し、更に円中の矢印は光の偏光方向を示す。横向きの矢印は光が紙面に平行に偏光していることを意味し、上下方向の矢印は光が紙面に垂直方向に偏光していることを示す。第4図(a)図は液晶に電場が印加されていない場合である。17は2色性色素の吸収波長の光の偏光方向を示す。2色性色素の

吸収波長を有する入射光の2色性色素分子の分子長軸方向と一致する偏光は、液晶層を通過する時に2色性色素分子により吸収されるので、液晶層を通過後は17の円中に示すように紙面に平行な偏光の光が存在する。一方、色素の吸収波長から離れた光はいずれの偏光も色素で吸収されないので、液晶層を通過後も全方向に偏光している。偏光板13は紙面に平行方向に偏光方向を有するので、紙面方向に偏光した色素の吸収波長の光をそのまま透過する。また色素の吸収波長から離れた全方向に偏光している光の中で紙面に平行成分のみを透過する。偏光板を透過した光はいずれの波長も18の円中に示されるように紙面に平行に偏光しており、反射板14で偏光方向を変化することなく反射して再び偏光板を透過し、20の円中に示されるように紙面に平行に偏光している。紙面に平行な偏光は色素分子の長軸方向と直交しつつ液晶層を通過するので、色素分子により吸収されることなく液晶層を通行し、上基板を透過して空気中に戻る。上述のように電場が零の場合は色素による光の吸収の効果が小さいために液晶セルは強い着色を生じない。

第4(b)図はくし歯状透明電極間に電圧を印加した場合を示す。15の点線は電気力線を示す。くし歯状透明電極間に電圧を印加する方法を第2(a)図に示す。第2(a)図で7はリード線、8は駆動用電源である。対向する電極間に電位差があるので第4(b)図の15の点線で示される電気力線が生じる。液晶の分子長軸方向の誘電率が短軸方向のそれより大きいネマチック液晶を用いるので、液晶の分子長軸は電気力線の方向にそって第4(b)図に示すように紙面に平行に再配列する。液晶中に混合された2色性色素分子も周囲の液晶分子に従って第4(b)図に示すように色素分子の分子長軸を紙面に平行方向に再配列する。この再配列は液晶分子の基板に平行な面内での回転運動のみで達成されるので電場に対する応答時間が短い。電極のない部分の光学的性質は第4(a)図の場合と同様である。第4(b)図の大きい矢印はくし歯状透明電極の部分を通過する光の通行方向を示している。22～27の円中の矢印はくし歯状透明電極の部分を通過する光の偏光方向を示す。22は入射光があらゆる方向に偏光していることを示す。色素の吸収波長の光の紙面に平行な偏光成分は、偏光方向が色素分子の分子長軸方向と一致しているので色素で吸収される。よつて色素の吸収波長の光は液晶層を通過したのち23の円中に示されるように紙面に垂直方向の偏光のみを有する。この偏光方向は紙面に平行な偏光板の偏光方向と直交しているので、色素の吸収波長の光は反射板まで到達しない。したがつて液晶セルから戻る光の中に色素の吸収波長の光が欠除するので、くし歯状透明電極の部分は強く着色して見える。すなわち、くし歯状透明電極間に電圧を印加することにより液晶セルを強く着色できる。

第5(a)、(b)図にn型のネマチック液晶を用いた実施例の一例を示す。くし歯状透明電極の長手方向に垂直方向の断面図である。偏光板は紙面に平行に偏光方向を有している。

基板面に配向処理を施し、n型の液晶分子および2色性色素分子は、それらの分子長軸が基板面に平行で、上基板面上では紙面に垂直に、下基板面上では紙面に平行に配列させる。第5(a)図は電場が零の場合である。液晶層を1度通過した色素の吸収波長の光は第4図の場合と同様な機構で色素に吸収され、29に示すように紙面に垂直方向の偏光のみを有する。紙面に垂直な偏光方向を有する偏光板を透過し、反射板で反射して再び偏光板を透過する。色素分子長軸に垂直方向に偏光しているから液晶層を吸収されることなく透過し、上基板を経て空気中に戻る。上述のように、電場が零の場合は色素による光の吸収の効果が小さいために液晶セルは強い着色を生じない。第5(b)図はくし歯状透明電極間に電圧を印加した場合である。分子長軸に直角方向の誘電率が長軸方向の誘電率より大きいn型の液晶は基板に平行な面内で回転して第5(b)図に示すように液晶分子長軸を紙面に垂直に再配列する。2色性色素分子も周囲の液晶分子とともに色素分子長軸を紙面に垂直に再配列する。34～39の円中の矢印はくし歯状透



明電極の部分を通過する光の偏光方向を示す。55は色素の吸収波長の光が断面に平行に偏光していることを示す。この偏光板は3の偏光板の偏光方向と直交しているので、色素の吸収波長の光は反射板まで到達しない。したがつて液晶セルから戻る光のスペクトル中に、色素の吸収波長の光が欠除するので、くし歯状透明電極の部分は強く着色して見える。

本発明はくし歯状透明電極とゲストホスト効果を組み合わせることにより、1枚の基板上にのみ透明電極を形成すればよく、液晶セルの構造を簡単にした。このため液晶セルの材料費が減少し、また上下基板の対向する電極の位置合わせも不要になり、液晶セルの組み立てが容易になつた。また1枚の基板からリード線を取り出すことが可能であるから液晶セルと外部回路の接続が容易になり、接続の信頼性を向上させる。また表示部分を着色することが可能となり、人間の眼に見やすい高品質の表示装置を可能とした。さらに電場による液晶分子の同一平面上での回転の再配列の機構を応用しているので、応答時間が大きく改善された。

4. 図面の簡単な説明

第1図、第2図、第3図は従来の液晶セルを示し、第1図は断面図、第2図(a)はくし歯状透明電極の正面図、第2図(b)はくし歯状透明電極の長手方向に直角方向の断面図、第3図はゲストホスト効果方式の説明図、第4図、第5図は本発明による液晶色表示装置の一実施例で、第4図(a)はP型液晶に電圧が印加されていない状態を示す断面図、第4図(b)はくし歯状透明電極に電圧を印加した場合の断面図、第5図(a)はn型液晶に電圧が印加されていない状態を示す断面図、第5図(b)はくし歯状透明電極に電圧を印加した場合の断面図である。

5…くし歯状透明電極

9…ネマチック液晶分子、

10…2色性液晶分子　　15…偏光板

16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39…

…光強度ベクトル

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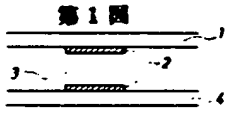
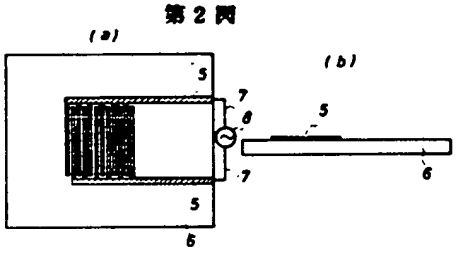
・　・　金　山　敏　彦

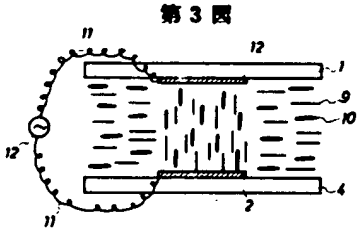
第1図



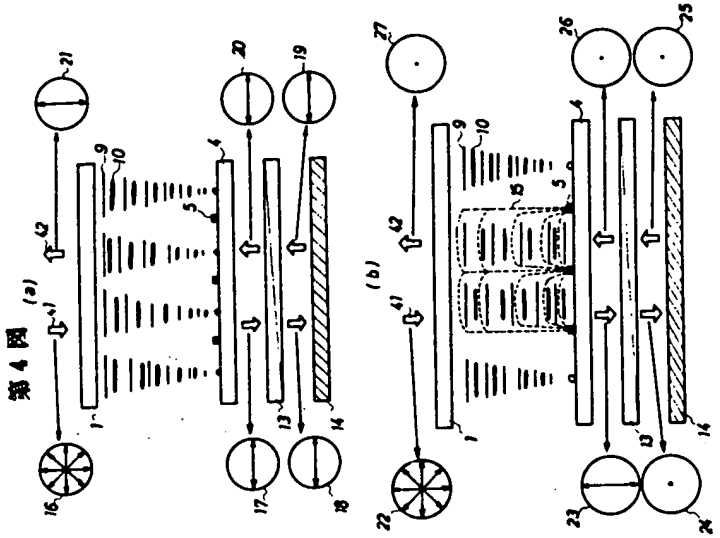
第2図



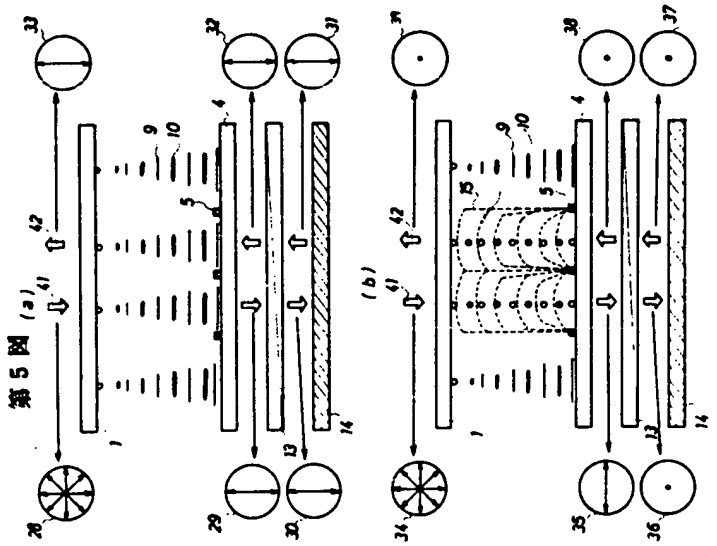
第3図



第4図



第5図



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